A Systems Engineering Approach to Managing Technical Data

Integrated Data Management System

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During the past 20 years, there has been an increasingly more obvious need to maintain system-level documentation in a common digital data environment. A common data environment will enable much more consistency in the data contained within the numerous technical documents associated with today's complex weapons systems. That is because there are numerous inconsistencies in nearly all of the technical documents of the modern weapons systems in use today.

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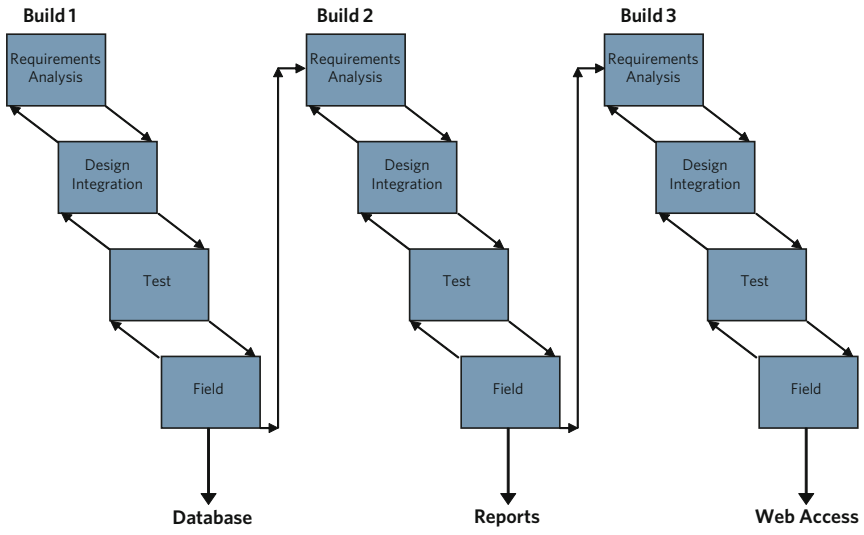
A typical DoD weapons system contains technical manuals, planned maintenance system (PMS) maintenance requirement cards (MRCs), maintenance and operator training course materials, parts lists, and so on. The technical information contained within those documents is typically developed with a variety of software products. For example, most technical manuals were typically created in Adobe® FrameMaker, or Microsoft® Word, while PMS MRCs were developed in Standard Generalized Markup Language. The format of the data in a variety of technical and logistics documentation associated with a system can easily exceed 30 to 40 unique and separate data formats created by different software systems. The large variance of software programs can lead to numerous problems with skill level, expertise, licensing, compatibility, storage, etc., as well as result in inconsistent and unreliable technical data across the various documents. That significantly increases the amount of work required to research technical issues and costs the government a great deal of money each year.

Furthermore, when the weapons system is initially developed, all of the technical documentation appears to contain identical information, but in reality, there are slight differences. This variation in documentation is a result of several factors: different personnel developing different documents, different software tools, etc. Content variation can result in potentially serious conflicts in the technical data supplied to the warfighter and can result in numerous manhours wasted researching incorrect or inconsistent technical information, not to mention the potentially serious consequences of inconsistency in safety-related issues.

Modified Waterfall Incremental Build Model



As the weapons system is supplied to the field, several different personnel will maintain the technical documentation in their native formats. As changes occur and are incorporated into the system or technical specification data is updated, the entirety of the technical documentation is not always corrected. Therefore, the technical documents often diverge further and further from each other. A quick look into the systems part ordering information will clearly illustrate the problem. Parts information is usually maintained in the technical manuals, PMS MRCs, allowance parts list, weapons systems file, training course material, user's logistics support summary, etc.; and a surprising amount of data variation currently exists in those documents. The variation is partly because technical personnel do not change the information in all related technical documents. Some of the documents had variations from the start, requiring quick and efficient data comparison between the various formats. All of that results in a potentially dangerous situation of inconsistent data for the warfighter. A more efficient manner of technical data management is required to ensure all of a system's technical data is as consistent and maintainable as possible.

Conversion to Digital

The DoD Policy for Transition to a Digital Environment mandates a DoD digital environment by the end of 2002. This started on July 2, 1997, when Deputy Secretary of Defense John P. White signed the "Policy for the Transition to a Digital Environment for Acquisition Programs." The policy directed DoD program managers to establish data management systems and digital environments that allow every activity involved with a program throughout its total life cycle to exchange data digitally. One of the essential and most data-intensive elements of the logistics portion of this digital environment is product data. Product data is the technical and management data required to field, operate, and support DoD weapons systems. Where are your programs at with accomplishing the intent of the digital data directive?

Taking the DoD digital policy to heart, a much more efficient method of developing and maintaining weapons system technical data is possible if all documents are developed in a common data environment. In such a data environment, technical data is easily stored, maintained, upgraded, and changed as required. When a technical change is made to the data within the data store, all of the references to that data are also changed. Such an environment can be efficiently created with any of the various database/data store tools commonly in use today such as Oracle®, Sybase®, etc.

With the off-the-shelf report generation tools available with most of the larger database systems, reports can be generated to provide the functionality as well as the look and feel of existing technical manuals, training course material, PMS MRCs, parts lists, etc. Since the core data comes from the same source—i.e., the common data environment—the data is fully consistent. Any required changes to existing data will be properly reflected in all documentation immediately upon incorporation of the change in the master database/data store. Users/maintainers can easily access the data via a Web interface. Since security is an issue in DoD weapon systems, extensive efforts in the areas of encryption/decryption can be applied to the data, and user access control and safeguards can be incorporated to prevent unauthorized disclosure of the data.

Systems Engineering Process

To develop an integrated data management system in the most efficient manner, a modified waterfall incremental build model, such as that depicted in the figure on this page, should be used. The actual steps in each block will be refined

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based on input and consultation with database/data stores and system technical experts.

Although the principles of systems engineering are typically applied only to a hardware development program and not to a software intensive development, there are many benefits to applying a formal systems engineering process to any system development. Systems engineering principles and methods would be applied to all aspects of the management and engineering development phases during the development of the project.

The first step in accomplishing such a data management system would be to perform a requirements analysis based on the needs and inputs from users as well as engineering, logistics, and system managers; and then accomplish interface definition and control, overall system trade studies with sensitivity analysis, and concept definition and exploration. At that point, the system would start to develop into a potentially useful product, at least from a conceptual point of view. The next application of systems engineering would be in the design and integration stage, where the project would start to resemble a real system.

The system development should be accomplished in units, which are typically the lowest software unit and contain approximately 100-200 lines of code. The units are then combined and become part of the functional modules. Those units and modules would significantly simplify the management of the project and enable more efficient debugging of any problems or abnormalities that may be encountered in the software coding portion of the design. After each unit is properly coded, the unit would be tested with other related units to ensure unit-to-unit functionality. This unit and module level management/testing of the project will enable efficient peer review of software units and proper functionality of the modules that are developed.

After all of the functional units and modules are developed, full integration development would occur. Since this is a modified waterfall incremental build, the software design and development will be developed in phases that allow increasing levels of capability to be fielded in a shorter period of time compared to a serial development process. Unit-to-unit integration would naturally lead into full integration testing to ensure all of the system requirements are fully met by the design and also to ensure the overall system performs as designed.

An Efficient System

The systems engineering concept for an integrated data management system will enable the warfighter to operate and perform maintenance on deployed systems in a much more effective and efficient manner. DoD personnel would trust the data more and would be more likely to provide meaningful input for improvements to the data as well as the integrated data management system tool. It is my desire that this article will enable more thorough research into the premise of integrated data environments as well as provide sufficient formalization of the concept to the point required to actually obtain funding to implement this type of system as a proof of concept. This system would not only help the warfighter but also help the engineering, logistics, and program management personnel as well.

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